

SYNTHESIS OF EXISTING INFORMATION ON MEADOW JUMPING MICE (*ZAPUS HUDSONIUS*) IN THE NORTHERN GREAT PLAINS

An information review compiled for the U.S. Fish and Wildlife Service, Region 6,
Denver, Colorado

by

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ABSTRACT

New evidence indicates that a subspecies of meadow jumping mouse occurring in Colorado and Wyoming (*Zapus hudsonius preblei*) that is listed as threatened under the Endangered Species Act may be genetically indistinguishable from another subspecies that occurs in the Black Hills and Bear Lodge Mountains to the north. This review was undertaken to provide the U.S. Fish & Wildlife Service with information pertaining to subspecies of *Z. hudsonius* in the Northern Great Plains. Information was obtained by consulting published literature, unpublished reports, and biologists familiar with this species. A taxonomic history of the subspecies of *Z. hudsonius* in the Northern Great Plains is provided to illustrate the criteria by which current groups were assigned. Few new occurrence records were uncovered during this review from arid parts of eastern Wyoming. Too few surveys have been conducted in the area between the currently documented ranges of *Z. h. preblei* and *Z. h. campestris* to rule out the possibility that intermediate populations exist. It is unknown if the subspecies *Z. h. campestris* is isolated to the Black Hills region. The close proximity of two other subspecies (*Z. h. intermedius*, and *Z. h. pallidus*) in the area, combined with the lack of systematic surveys to delineate their distributions, makes it difficult to rule out the possibility that their ranges overlap that of *Z. h. campestris*. Detailed studies aimed at characterizing the habitat needs and survival of *Z. h. campestris* have not been conducted. Thus, there are currently insufficient data to determine if ecological differences exist between *Z. h. preblei* and *Z. h. campestris*. Information on the relative abundance of *Z. hudsonius* in the Northern Great Plains is limited and biased and there are no reliable long-term data with which to evaluate population trends in the region.

INTRODUCTION

A recent study by Ramey et al. (2004) indicates that Preble's meadow jumping mouse (*Zapus hudsonius preblei*), which occurs in Colorado and southeastern Wyoming, may not be taxonomically distinct from another subspecies to the north. These researchers suggest that the subspecies now recognized as *Z. h. preblei* is not taxonomically distinct from *Z. h. campestris*, which occurs in northeastern Wyoming, western South Dakota, and southeastern Montana. Soon after this information was made available, the U.S. Fish and Wildlife Service (USFWS) received petitions to remove *Z. h. preblei* from the

Federal List of Threatened and Endangered Wildlife and Plants (USFWS 2004). One of the major issues raised by the petitioners was the possible existence of suitable habitat, and thus contiguous occurrence of the species, between documented populations of *Z. hudsonius* in southeastern and northeastern Wyoming. Such a distribution would have important implications toward the presumed isolation of *Z. h. preblei* and this subspecies' current recognition under the Endangered Species Act (ESA).

Details concerning the distribution of *Z. h. preblei* in Colorado and southern Wyoming were gained through survey work since the early 1990's, but distribution information from areas north and east of Douglas, Wyoming, is not available. Preble's meadow jumping mouse has been found in parts of Wyoming that are less than 150 km southwest of where *Z. h. campestris* is known to occur, but there is little information on the presence of meadow jumping mice between these areas. Furthermore, it remains to be determined if the range of the subspecies *Z. h. campestris* is restricted to the Black Hills region. Such information would be important, should *Z. h. preblei* be synonymized with *Z. h. campestris*. Two other subspecies of the meadow jumping mouse (*Z. h. intermedius* and *Z. h. pallidus*) occur within 100 km of *Z. h. campestris*, but the amount of contact between subspecies in the region is unknown. Previous researchers postulated disjunct distributions between *Z. h. campestris* and subspecies to the east (Jones et al. 1983). However, the range of *Z. h. campestris* has not been clearly defined.

The objective of this project was to review and summarize available information (published and unpublished) pertaining to *Z. hudsonius* on the Northern Great Plains, with a specific focus on distribution, habitat affinities, relative abundance, and population trends of subspecies, excluding *Z. h. preblei*, that occur there (*Z. h. campestris*, *Z. h. pallidus*, and *Z. h. intermedius*).

METHODS

Information contained in this report was acquired through three avenues: 1) queries of literature databases and libraries for published documents; 2) contacting government and non-government agencies for unpublished reports and survey records; and 3) interviewing individuals with experience trapping small mammals in the Northern Great Plains. This search targeted information on *Z. hudsonius* in the states of Wyoming, Montana, North Dakota, South Dakota, Kansas, Nebraska, and the Canadian provinces of Saskatchewan and Manitoba. In addition, several major museum collections and state natural heritage programs were queried for recent specimen and capture records. Occurrence records were georeferenced and incorporated into a geographic information system (GIS) for mapping. Estimated maximum error of georeferencing was 5 miles, but spatial error for most localities is estimated to be < 1 mile.

TAXONOMIC HISTORY

Because 4 different subspecies of *Z. hudsonius* occur in the region, provided herein is a brief taxonomic history of the genus *Zapus* and how these groups were determined.

Preble (1899) first revised *Zapus* based on the skin and skull characteristics of 776 specimens. He concluded that there were 10 species in the genus, two of which were *Z. hudsonius* and *Z. princeps*. The latter species were comprised of 5 and 3 distinct subspecies, respectively. Specimens of *Z. hudsonius* from the states of North Dakota, Montana, South Dakota, Wyoming, Nebraska, Colorado, and Missouri ($n = 35$) were all classified as *Z. h. campestris*. Preble (1899) made no mention of *Z. h. campestris* being isolated from other populations and stated that, “While no good intergrades have been examined, it doubtless does intergrade with true *hudsonius* in western Minnesota.” Thus, most specimens of *Z. hudsonius* from Colorado, Wyoming, and the Northern Great Plains were assigned to the subspecies *Z. h. campestris* until 1950. In the early 1950’s, Cockrum and Baker (1950) first refined the subspecies *Z. h. campestris* by applying the subspecific epithet *Z. h. pallidus* to specimens from Nebraska, Kansas, and Missouri.

Krutzsch (1954) revised the taxonomy of the genus after studying morphological characteristics of approximately 3,600 specimens of *Zapus*. This revision recognized only three distinct species (*Z. hudsonius*, *Z. princeps*, and *Z. trinotatus*), each comprised of between 4 and 11 subspecies. Krutzsch relegated the majority of species previously recognized by Preble (1899) to subspecific status. This reduction in the number of distinct species was based on the employment of Mayr’s (1942) species concept of reproductive isolation. Krutzsch retained the name *Z. h. campestris*, but restricted its use to specimens from the Black Hills and Bear Lodge Mountains of Wyoming, South Dakota, and adjacent southeastern Montana. Individuals from North Dakota, and northwestern, central, and eastern South Dakota were classified as the subspecies *Z. h. intermedius*. The study by Krutzsch indicated some level of intergradation between most subspecies of *Z. hudsonius* on the Northern Great Plains, but gave no indication of intergradation between *Z. h. preblei* and any other subspecies. Morphological characteristics examined by Krutzsch also hinted that contact was limited between *Z. h. campestris* and other subspecies to the east and north, because specimens of *Z. h. campestris* appeared to go against the clinal variation seen from east to west in other races of *Z. hudsonius* across North America (Krutzsch 1954).

Research during the 1960’s and 1970’s did little to clarify the distribution of subspecies in the Northern Great Plains. For example, Jones (1964) noted that individuals from northwestern Nebraska were larger than *Z. h. pallidus* in eastern parts of the state and approached measurements of *Z. h. campestris* in southwestern South Dakota and adjacent Wyoming. However, the color of these western Nebraska specimens differed from those in the Black Hills and the possibility of yet another subspecies was suggested. Robertson (1971) examined the morphological characteristics of 390 specimens of *Z. hudsonius* from Kansas, Nebraska, and the Dakotas and found continuous, clinal variation across the eastern and central parts of all of these states. This research also found evidence of continuous variation between *Z. h. intermedius* and *Z. h. pallidus* in Nebraska, but Robertson refrained from formally questioning the validity of *Z. h. intermedius* as a distinct subspecies due to the lack of samples from key areas. One year later, Genoways and Jones (1972) summed up the situation by stating, “The systematics of *Zapus* occurring on the Great Plains is in need of critical review...”

Jones (1981) carried out the most thorough systematic review of the genus *Zapus* to date, by examining the morphology of almost 9,900 specimens from across North America. This analysis quantified more morphological characteristics of more specimens than any prior or subsequent effort. Jones concluded that *Z. trionotatus* was not a valid taxon, as classified by Krutzsch (1954), and suggested reducing the number of species in the genus to two (*Z. hudsonius* and *Z. princeps*). At the subspecific level, Jones (1981) found few differences in morphology between *Z. h. preblei* and subspecies elsewhere. He therefore concluded that there was “no evidence of any population of *Zapus hudsonius* being sufficiently isolated or distinct to warrant subspecific status” and that “No named subspecies is geographically restricted by a barrier, with the possible exception of *Z. h. preblei*.” Jones (1981) made these statements based on the subspecies concept proposed by Whitaker (1970a). This concept stated that: 1) subspecies must be divided by primary isolating mechanisms that stop or significantly reduce gene flow; 2) in the absence of primary isolating mechanisms, subspecies would still be capable of interbreeding; and 3) that the existence of primary isolating mechanisms can be inferred from the genetic distinctness of subspecies, as evinced by unique characteristics. The conclusions reached by Jones (1981) were never incorporated into the formal taxonomy of the genus, because they were never published in a peer-reviewed journal. Therefore, the scientific community never formally assessed the validity of this work.

Riggs et al. (1997) examined the mitochondrial DNA sequences of *Zapus* and made two findings that pertain to subspecies of *Z. hudsonius* in the Great Plains: 1) samples of *Z. h. preblei* from Colorado and southeastern Wyoming formed a coherent group, but were “not strongly differentiated” from samples of *Z. h. intermedius* from Minnesota; and 2) two specimens of *Z. hudsonius* from near the Black Hills and one from Garden County, Nebraska were genetically indistinguishable from the samples of *Z. h. preblei* that they analyzed. The latter result is relevant because these samples came from three different subspecies (*Z. h. campestris*, *Z. h. pallidus*, and *Z. h. preblei*).

Ramey et al. (2004) presented evidence, based on mitochondrial DNA analysis, that the genetic diversity of *Z. h. preblei* falls within the range of genetic diversity exhibited by *Z. h. campestris*, suggesting that the former subspecies may actually be a southern population of *Z. h. campestris*. Contrary to the findings of Riggs et al. (1997), the results obtained by Ramey et al. (2004) indicate that genetic differences exist between *Z. h. pallidus* and other subspecies.

DISTRIBUTION

Zapus hudsonius occurs across a broad transcontinental range (Whitaker 1970b). The distribution of a representative sample of occurrence records for *Z. hudsonius* from the Northern Great Plains is illustrated in Figure 1. The general pattern, based on these records, is an overall species distribution that becomes patchier in western areas, likely reflecting a decrease in the availability of the mesic habitats favored by *Z. hudsonius*.

Substantial gaps exist in the distribution of *Z. hudsonius*, the largest of which falls between the Black Hills region (*Z. h. campestris*) and a population to the southwest (*Z. h.*

preblei). The nearest minimum distance between the documented edges of these groups is about 150 km. This is one of the apparent gaps in distribution that led previous researchers to conclude that the population of *Z. h. preblei* in Colorado and southeastern Wyoming is geographically isolated.

In his original description of the subspecies, Krutzsch (1954) stated:

To the east the range of *Z. h. preblei* is separated from that of *Z. h. pallidus* (western Kansas and southwestern Kansas), by several hundred miles of mixed and short grass prairie. Much of this area is unsuitable to jumping mice but local marshy places might be inhabited. Much territory inhospitable to *Zapus* intervenes also between the ranges of *Z. h. preblei* and *Z. h. campestris*. This area (northern Platte, Goshen, and eastern Converse, Niobrara, and southern Weston counties, Wyoming) is chiefly rolling hills and short grass prairie and, like that to the east, is only locally suitable for *Zapus*. If jumping mice do occur in suitable places in these intervening areas it is to be expected that they will show intergradation between subspecies concerned.

The lack of suitable habitat is generally accepted as the main factor isolating *Z. h. preblei* in southeastern Wyoming from other populations of *Z. hudsonius* to the east and north, but few surveys for *Zapus* have been conducted in these gaps (Fig. 2; Beauvais 2001).

This review found only a single occurrence record for *Z. hudsonius* in the area between the previously documented distributions of *Z. h. preblei* and surrounding subspecies. This record was recently discovered by personnel from the Wyoming Game and Fish Department and the U.S. Department of Agriculture among survey data housed at the Wyoming Department of Environmental Quality. According to the record, a *Z. hudsonius* was captured during 1984 in Campbell County, Wyoming, about 10 mi. southeast of Gillette, but no voucher specimen or photograph was taken (G. Beauvais, pers. comm.). This occurrence, coupled with the fact that very few surveys have been conducted in east-central Wyoming, make it difficult to rule out the possibility that intermediate populations of *Z. hudsonius* exist. Four nights of survey work during early August of 2000 in the Thunder Basin National Grassland, northeastern Converse County, Wyoming, failed to detect the presence of *Zapus* (T. Byer, pers. comm.). Surveys during the summer of 2004 on the east flank of the Bighorn Mountains also failed to detect *Z. hudsonius*, but this effort was confounded by high trapping rates of non-target species (A. Clark, pers. comm.). Most survey work in Wyoming has focused on the southeastern part of the state, in compliance with management efforts directed toward *Z. h. preblei*. In addition, personnel from the Wyoming Natural Diversity Database (WYNDD) conducted surveys in the region east of the Laramie Range during the summer of 2004, yet did not detect *Zapus* at sites that were apparently suitable (G. Beauvais, pers. comm.). Considering the amount of potential habitat in eastern Wyoming that has not been sampled and because the presence of *Z. hudsonius* is often difficult to detect (Hafner and Yensen 1998), additional survey work is needed in the region. In the course of this review, it was determined that only one biologist, Aaron Clark of PIC Technologies, is

planning surveys for *Zapus* in eastern Wyoming during the summer of 2005 (A. Clark, pers. comm.).

Whereas the gaps in distribution between *Z. h. preblei* and other subspecies seem relatively large, populations of *Z. h. campestris* in the Black Hills and Bear Lodge Mountains are relatively close (< 120 km) to both surrounding subspecies (*Z. h. pallidus* and *Z. h. intermedius*). The relatively close proximity of these subspecies in the Northern Great Plains, combined with the lack of systematic surveys to delineate their distributions, makes it difficult to rule out the possibility that their ranges are in contact. However, mammalogists who have trapped extensively around the Black Hills speculate that *Z. h. campestris* is separated from more eastern subspecies by the lack of suitable habitat between these groups (Jones et al. 1983).

One of the potential gaps in suitable habitat between *Z. h. campestris* and surrounding subspecies lies to the north. Available evidence indicates that occurrence records of *Z. hudsonius* from northwestern South Dakota and adjacent southeastern Montana represent an isolated population. Andersen and Jones (1971) collected 11 specimens from northwestern South Dakota from what they called a “relict” population “restricted to a shrub-grass habitat adjacent to a small spring-fed stream and impoundment” and postulated that other isolated populations may exist in the few other suitable mesic habitats of the area. They “trapped extensively, yet unsuccessfully, for *Zapus* in such situations.” However, occurrence records exist from the Long Pine Hills and Little Missouri River in adjacent Carter County, Montana (Anderson and Jones 1971). Morphological analyses of specimens from this area suggested they were an intermediate form between *Z. h. campestris* and *Z. h. intermedius*, but resembled the former more than the latter (Kruttsch 1954, Anderson and Jones 1971, Robertson 1971, Lampe et al. 1974).

Another potential gap separating *Z. h. campestris* from other subspecies occurs to the southeast. Kruttsch (1954) noted the lack of specimens from the Pine Ridge and adjacent areas of northwestern Nebraska, as well as the Platte River drainage. Robertson (1971) suggested that the “lack of suitable habitat, resulting principally from aridity” is a major factor leading to apparently isolated populations of *Z. hudsonius* on the Great Plains, such as a population that is apparently isolated in the sandhills region of Nebraska.

This review was unable to find records or mention of any recent systematic surveys for *Z. hudsonius* in or around the Black Hills region. There seem to be no current efforts to study the biology of *Z. hudsonius* in the Black Hills region or to determine the extent of its distribution on the surrounding plains (D. Backlund, pers. comm.). Limited anecdotal information, mostly resulting from non-target studies, is available. No *Z. hudsonius* were reported as captured during small mammal surveys in riparian habitats between Mobridge and Fort Thompson, South Dakota (Rumble and Gobeille 2001). Several other studies of small mammal communities in South Dakota did not turn up *Z. hudsonius*, likely because they were not conducted in mesic or riparian habitats (Sieg 1988, Deisch et al. 1990, Pinkert et al. 2002). None were reported as being captured by Cooper (1868) or Goldan (1982) from adjacent southeastern Montana. However, the problematic nature of gleaned information from such reports is illustrated by the latter case. Goldan (1982)

trapped for 10 days over the course of 2 summers and opened the traps between 9 a.m. and 1:00 p.m., thus likely missing the peak of nocturnal activity by *Z. hudsonius*. No *Zapus* were reported from small-mammal trapping in croplands of Nebraska (Cable and Case 1985). Choate and Fleharty (1975) discuss a possible record of *Z. hudsonius* in north central Kansas, based on a report of single individual captured “among willow brush on the bank of a stream” and speculate that *Z. hudsonius* may have occurred in the region before agricultural conversion and the great drought of the 1930’s.

The distributions of subspecies of *Z. hudsonius*, as originally mapped by Krutzsch (1954), are overlain on current occurrence records in Figure 3. It is clear from this map that our understanding of where the species occurs has increased since the original subspecies boundaries were drawn. For example, when Krutzsch mapped the distributions of *Z. h. pallidus* and *Z. h. intermedius* in South Dakota, few records existed from the central and eastern portions of the state (Fig. 3 inset), perhaps indicating geographic separation of the two subspecies. Numerous occurrence records now exist from this area, obscuring any geographical separation of populations. Considering the close proximity of subspecies in the Black Hills region and the lack of survey data from intermediate areas, the possibility of contact among all 3 subspecies cannot be ruled out at present.

It is likely that habitat suitable for *Z. hudsonius* is becoming increasingly available across western parts of the Great Plains with the westward expansion of riparian forests and mixed-grass prairie (Knopf 1986, Frey 1992, Choate et al. 1991, Beauvais 2001). Choate et al. (1991) postulated that, based on the recent appearance of *Z. hudsonius* in some parts of northeastern Kansas, the species is dispersing through vegetation along roadside ditches and riparian corridors into new areas. These patterns indicate an increasing likelihood of connectivity between populations of *Z. hudsonius* in the Great Plains (Beauvais 2001).

HABITAT AFFINITIES

In the eastern parts of North America *Z. hudsonius* occurs in relatively mesic habitats, such as meadows, abandoned fields, along the edges of marshes, ponds, and streams, as well as occasionally in woodland habitats (Over and Churchill 1941, Jones 1964, Whitaker 1970b, Jones et al. 1983). Adequate herbaceous or grassy ground cover is essential for this species and in the Northern Great Plains this requirement generally limits the distribution of *Z. hudsonius* to riparian areas (Jones et al. 1983).

This review found no quantitative studies on the habitat affinities of *Z. hudsonius* in the Northern Great Plains that are comparable to those conducted in Colorado and Wyoming for *Z. h. preblei* (e.g., Armstrong et al. 1997, Keinath 2001, Schorr 2001, Schorr 2003). Because of this, it is currently not possible to determine whether significant ecological differences exist between *Z. h. preblei* and other subspecies in the Great Plains. However, anecdotal reports provide a general picture of the types of habitats in which *Z. hudsonius* has been encountered in the region. The majority of these anecdotal reports come from areas surrounding the Black Hills and Bear Lodge Mountains.

In the Black Hills, Turner (1974) concluded that *Z. h. campestris* “most frequently occurs in riparian communities along small streams in valley meadows, or in open, moist habitats with coniferous forests that support a low undergrowth of forbs and grasses.” Although *Z. h. campestris* does occur in suitable habitats on the surrounding plains, it was most frequently encountered in the hills at elevations up to 6500 feet (Turner 1974). Easton and Wrenn (1988) reported capturing numerous ($n = 70$) *Z. h. campestris* over several years in Spearfish Canyon of the Black Hills. The capture site was described as a perennial stream bordered by a forest composed of ponderosa pine (*Pinus ponderosa*), white spruce (*Picea glauca*), paper birch (*Betula papyrifera*), and bur oak (*Quercus macrocarpa*). Understory vegetation at the site included; blackeye Susan (*Rudbeckia hirta*), western yarrow (*Achillea millefolium*), prairie coneflower (*Ratibida columnifera*), showy milkweed (*Asclepias speciosa*), and poison ivy (*Toxicodendron radicans*; Easton and Wrenn 1988). Other understory riparian vegetation found at capture sites of *Z. hudsonius* in the Black Hills included grasses, spearmint (*Mentha* spp.), yellow wood sorrel (*Oxalis stricta*), stinging nettle (*Urtica dioica*), ferns, driftwood, shrubs, liverworts, mosses, and sedges (Turner 1974). A comprehensive small-mammal trapping effort at Wind Cave National Park in the southern Black Hills found *Z. h. campestris* typically occurring in birch/aspen and the relatively common boxelder/chokecherry vegetation alliances (Duckwitz 2001). More so than with accounts from the surrounding plains, descriptions of capture sites from the Black Hills sometimes vary from the typical pattern of riparian areas bordering perennial streams. For example, Turner (1974) reported catching *Z. h. campestris* from marshy areas around lakes and reservoirs, as well as, “a dry wooded slope, a dry rocky meadow, and a dry ponderosa pine covered slope among boulders.”

In the Bear Lodge Mountains, several *Z. h. campestris* were recently captured in tall grass (approx. 0.5m) on the banks of a pool along a perennial stream (K. Geluso, pers. comm.). The pool was situated in the middle of a meadow surrounded by slopes of aspen and ponderosa pine forest.

In Carter County, Montana, approximately 80-100 km north of the Black Hills and Bear Lodge Mountains, *Z. h. campestris* was trapped in riparian and marshy habitats, as well as on a grassy upland slope (Lampe et al. 1974). Other accounts from eastern Montana and adjacent southwestern North Dakota describe the species (probably *Z. h. intermedius*) occurring in mesic habitats with a dense understory of tall and lush grasses and forbs (Matthews 1980).

In southwestern South Dakota, *Z. h. intermedius* occurred in marshes and lush riparian habitats of the Lacreek National Wildlife Refuge and was commonly encountered “in and among stands of cattails or sedges and in the branches of brushy vegetation” (Wilhelm et al. 1981). In southwestern North Dakota, Genoways and Jones (1972) found *Z. h. intermedius* most frequently in grassy areas beneath shrubs and trees in riparian habitats, but also among reeds in a marshy area. A single individual was captured on a grassy upland slope (Genoways and Jones 1972).

Farther east on the plains of South Dakota, Pendleton and Davison (1982) reported capturing *Z. hudsonius* in dry semi-permanent wetlands. Higgins et al. (1997) reported capturing 287 *Z. hudsonius* in eastern South Dakota and that the species was most abundant in wetlands, followed by grasslands, croplands, tree belts, and other woodlands (Higgins et al. 1997).

In Nebraska, *Z. hudsonius* occurs only in riparian areas bordering rivers and lakes in western parts of the state, but is more “generally distributed” and found in a wider variety of vegetation communities in the eastern part of the state (Jones 1964). Specimens taken at Crescent Lake National Wildlife Refuge in the sandhill region of Nebraska were found in a wet meadow and among willows and sedges near a lake (Gunderson 1973).

In Canada, *Z. h. intermedius* occurs only in extreme southwestern Manitoba (Hall 1981). The rest of the Prairie Provinces are occupied by the northern subspecies, *Z. h. hudsonius* (Hall 1981). Wrigley (1974) found *Z. h. intermedius* occupying a variety of cover types in the sandhills region of southwestern Manitoba, including grass-sedge, shrub, swamp, riparian forest, and savanna. None were encountered in mesic prairie habitats (Wrigley 1974). In another area of southwestern Manitoba, *Z. h. intermedius* was taken near a lake among grass and shrubs at the edge of a deciduous forest (Wrigley et al. 1991).

Considering the available evidence, there are no apparent patterns that indicate clear differences in habitat use between subspecies of *Z. hudsonius* on the Northern Great Plains. The possible exception is that *Z. hudsonius* may occupy a wider range of habitats in the Black Hills than on the surrounding plains. However, the latter statement remains conjecture in the absence of quantitative information.

RELATIVE ABUNDANCE AND POPULATION TRENDS

There are too few data available with which to make meaningful comparisons of relative abundance or to assess population trends among subspecies of *Z. hudsonius* in the Northern Great Plains. Populations of *Z. hudsonius* are known to experience substantial annual fluctuations in number (Quimby 1951), which makes comparison of data collected during different years questionable. For example, studies in Colorado indicate that it may not be unusual to see a doubling (or halving) of the number of individual *Z. hudsonius* in a given area from year to year (Meaney et al. 2003, Schorr 2003). Based on the results of a Colorado study, Meaney et al. (2003) suggested that accurately assessing the range of annual variation in a population of *Z. hudsonius* would likely take monitoring periods of 10 years or more. Such long-term monitoring of marked individuals has not occurred in any part of the species’ range. Furthermore, if temporal population fluctuations were not synchronous among spatially segregated populations, then within-year comparisons of different populations would be questionable. Also adding to the difficulty of gleaned information on relative abundance from the available information is the fact that few studies used the same types of traps and capture success differs among trap types. For example, several researchers found that *Z. hudsonius* were captured more frequently in snap traps (Matthews 1980, Pendleton and Davison 1982, Silvia and Case 1994, Hafner and Yensen 1998) or Havahart live traps (Sublinskis 1987, Najera 1994) than in Sherman

live traps. Furthermore, this review found no studies in which historical capture sites in the Northern Great Plains were revisited to detect the presence of *Z. hudsonius*. Most information on the relative abundance of *Z. hudsonius* comes from anecdotal accounts.

At a continental scale, Jones et al. (1983) postulated that the home ranges of *Z. hudsonius* may be larger in the Northern Great Plains compared to mesic eastern regions and local population densities appear to be lower in the western region.

In the Black Hills, Turner (1974) stated that *Z. h. campestris* was “common” and Easton and Wrenn (1988) reported capturing a total of 70 *Z. h. campestris* in a limited area of Spearfish Canyon between 1977 and 1985. No *Zapus* were captured during limited trapping for small mammals on 4 transects in the grassland flats of Wind Cave National Park during 1980-1981, but stream habitats were not sampled (Forde 1983). Duckwitz (2001) later captured as many as 7.2 *Z. h. campestris* per 1000 trap nights in riparian habitats of the same area. Average litter size for a sample of females from the Black Hills was 6.1 ($n = 14$) and was similar to the values reported from eastern regions (Robertson 1971).

In the nearby Bear Lodge Mountains, 4 *Z. h. campestris* were recently (15 August 1997) captured in a line of 10 Sherman traps placed for a single night in tall grass next to a creek (K. Geluso, pers. comm.).

In the plains of southwestern South Dakota, Wilhelm et al. (1981) stated, “The meadow jumping mouse is a common inhabitant of marshes and lush riparian habitats on Lacreek National Wildlife Refuge.” In eastern South Dakota, a total of 287 *Z. hudsonius* were captured during 2 years of trapping by Higgins et al. (1997); the species comprised 10.9% of the total sample of small mammals and capture rates varied with habitat type, ranging between 0.56 to 13.86 per 100 trap nights (Higgins et al. 1997).

In North Dakota, *Z. hudsonius* is less abundant than other mice (Bailey 1926), but is known to be locally abundant in riparian and mesic habitats in the southwestern part of the state (Genoways and Jones 1972). *Zapus hudsonius* comprised 8% of a sample of 296 rodents collected during an herbicide study of cattail marshes in eastern North Dakota (Mendoza et al. 1992). In southwestern North Dakota and southeastern Montana, only 24 *Z. hudsonius* were captured during 21,007 trap nights over two summers (Matthews 1980).

In Nebraska, Swenk (1908) reported *Z. hudsonius* as “rather rare” and Beed (1936) reported that “jumping mice” were uncommon during a single-summer survey of the Niobrara Game Preserve in north central Nebraska. Robertson (1971) remarked that, “Populations of jumping mice in eastern Nebraska are widely scattered and quite possibly low in density (if trapping records are reliable indicators of population numbers).” Remains of 1 *Z. hudsonius* were found in a sample of 90 owl pellets from Crescent Lake Wildlife Refuge, Garden County, western Nebraska (Rickart 1972). Nine specimens were taken during about 16 days of trapping over 3 summers at the Crescent Lake National Wildlife Refuge in the sandhill region (Gunderson 1973). In southeastern

Nebraska, Walker (1976) captured only 3 *Z. hudsonius* during 783 trap nights in June and August and 2 during 853 trap nights in September and November.

STATUS

There is no reliable information available to determine if populations of *Z. hudsonius* have declined or increased on the Northern Great Plains during the past century. Hafner and Yensen (1998) included *Z. h. campestris* on the IUCN Red List as “vulnerable,” stating that, “Assignment of *Z. h. campestris* is based on its highly restricted and fragmented distribution and the projected continuation in the decline in both extent and quality of its habitat.” Hafner and Yensen (1998) reported, “*Zapus h. campestris* is classified as Critically Rare with habitat decreasing [Houtcouper et al. 1985] in South Dakota.” However, *Z. h. campestris* was not among the mammals listed by Houtcouper et al. (1985) and was subsequently removed from the IUCN Red List of Threatened Species (www.redlist.org; checked 15 October 2004). *Zapus h. campestris* is now among the list of mammals being monitored by the state of South Dakota (D. Backlund, pers. comm.) and is listed as a “species of concern” in Montana. It is likely that loss of adequate riparian habitat in the Black Hills and Bear Lodge Mountains negatively impacts *Z. hudsonius* occurring there (e.g., Center for Native Ecosystems et al. 2004), but quantitative data on habitat requirements or population trends in the area are lacking. Furthermore, there is currently little information available on the amount of isolation experienced by *Z. h. campestris* in the Black Hills region and thus the amount of genetic exchange with populations to the north, east, and south.

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Figure 1. Distribution of occurrence records of *Zapus hudsonius* in the Northern Great Plains. Circles without center spots represent occurrence records compiled by the author of this report from the literature and museum collections. Circles with center spots represent records contributed by the Wyoming Natural Diversity Database (WYNDD). Records of potential *Z. hudsonius* from the WYNDD in western Albany County and Carbon County, Wyoming, were not mapped pending confirmation of species identification.

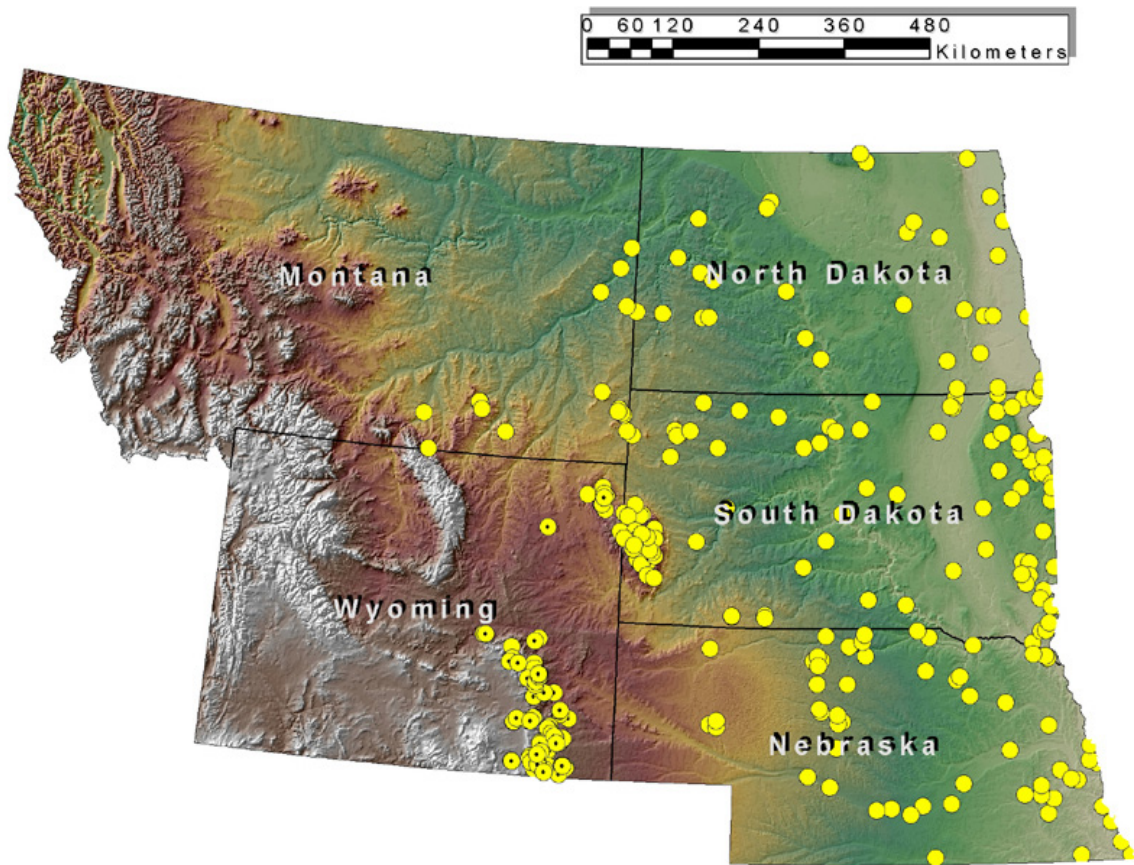


Figure 2. Distribution of *Zapus hudsonius* and negative survey sites. Asterisks denote surveys sites where *Zapus* were surveyed but not captured. Circles represent known occurrence sites. Negative survey data for this figure were provided by the Wyoming Natural Diversity Database.

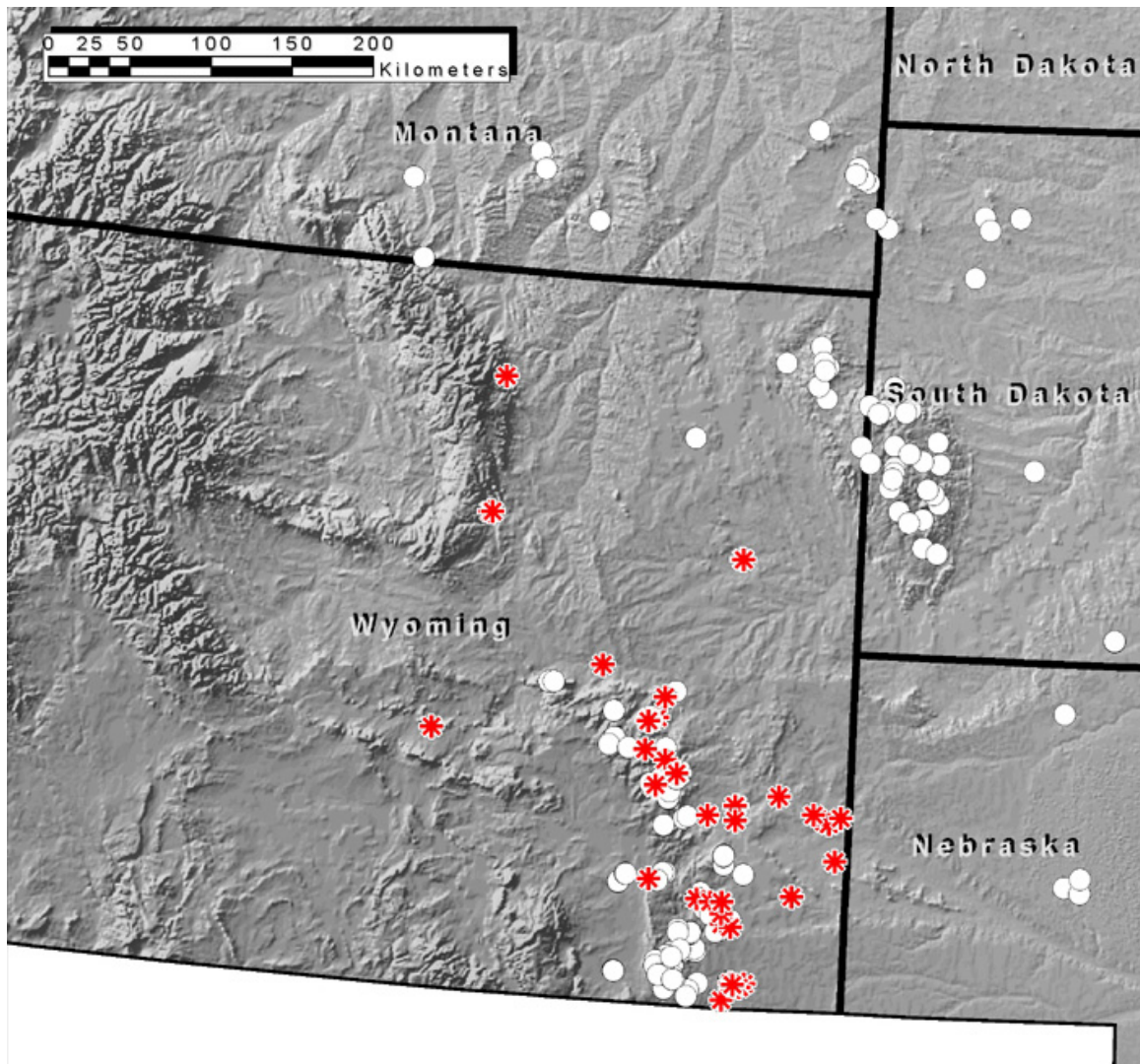
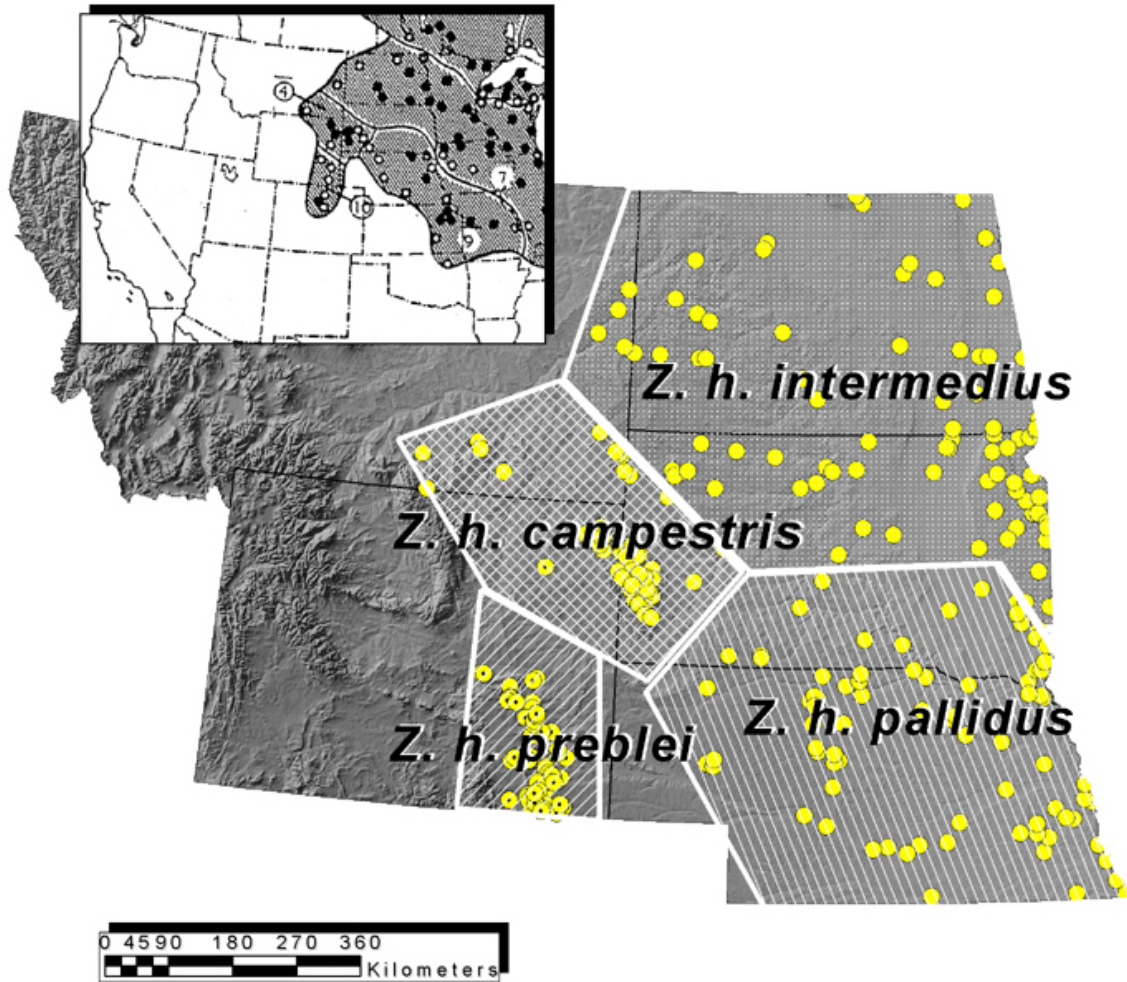


Figure 3. Subspecies boundaries of *Zapus hudsonius*, as originally mapped by Krutzsch (1954), overlain on current occurrence records. Inset at upper left of map shows original map published by Krutzsch and records that were available to him at the time. Current occurrence records mapped as in Fig. 1.



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